Notes on the genus *Gaeolaelaps* (Acari: Laelapidae) with a newly recorded species from China

Yi YAN1①, Qian ZHANG1, Xianguo GUO2, Lixia XIE1①

1. *College of Plant Protection, Shandong Agricultural University, Shandong Provincial Key Laboratory for Biology of Vegetable Diseases and Insect Pests, Tai'an, Shandong 271018, China*

2. *Vector Laboratory, Institute of Pathogens and Vectors, Dali University, Dali, Yunnan 671000, China*

Abstract: The genus *Gaeolaelaps* Evans & Till from China, including 20 species, is reviewed and an identification key to the Chinese species is provided. *G. gillespiei* Beaulieu, 2009 is reported from China for the first time, with redescription and illustrations. Three new mammal hosts are reported (*Anourosorex squamipes*, *Eothenomys miletus* and *Rattus steni*).

Key words: Mesostigmata; Hypoaspidinae; checklist; key; new host

中国殖厉螨属分类研究及一新纪录种记述（蜱螨亚纲：厉螨科）

闫毅 1①，张倩 1，郭宪国 2，谢丽霞 1①

1.山东农业大学植物保护学院，山东省蔬菜病虫生物学重点实验室，山东 泰安 271018；2. 大理大学病原与媒介生物研究所，云南 大理 671000

摘要：记述中国殖厉螨属 *Gaeolaelaps* Evans & Till 20 种（含 1 中国新纪录种），编制了该属中国已知种检索表。对采自云南小兽体表的中国新纪录种——吉氏殖厉螨 *Gaeolaelaps gillespiei* Beaulieu, 2009 进行了重描述和绘图，并记录了该种的寄主新纪录 3 种（四川短尾鼩 *Anourosorex squamipes*、大绒鼠 *Eothenomys miletus* 和斯氏家鼠 *Rattus steni*）。

关键词：中气门目；下盾螨亚科；名录；检索表；寄主新纪录

Introduction

The subfamily Hypoaspidinae Vitzthum 1940 includes a group of arthropods, which are usually classified as an independent subfamily in the family Laelapidae, order Mesostigmata, subclass Acari, class Arachnida in the phylum Arthropoda. As members of the subfamily Hypoaspidinae, mites of the genus *Gaeolaelaps* often are collected in litter, soil substrates, the nest of mammals or arthropods, or directly associated with insects (Krantz & Walter 2009). The taxonomy of *Gaeolaelaps* has a complicated history (Halliday & *Lindquist* 2007). It has been considered as a species group (Van Aswegen & Loots 1970), a subgenus of *Hypoaspis* sens. lat. (Karg 1962, 1982, 1987, 1989; Faraji *et al.* 2008) and a distinct genus (Ryke 1963; Hyatt 1964; Rosario 1981; Walter & Oliver, 1989). We herein consider *Gaeolaelaps* as a genus following Kazemi *et al.* (2014). *Gaeolaelaps* is a large cosmopolitan genus of Laelapidae

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Accepted 18 September 2018. Published 25 December 2018. Published online 20 November 2018.

① Corresponding authors, E-mails: miteyy@163.com; xielixia2006@163.com which consists of more than 100 described species (Nemati & Mohseni 2013; Kazemi *et al.* 2014). Prior to this paper, *Gaeolaelaps* consisted of 19 species in China (Teng 1982; Tenorio 1982; Gu & Bai 1991; Gu & Duan 1993; Bai *et al.* 1994; Xu & Liang 1996; Ma 1996, 1997, 2000a, b, 2004; Ma & Yin 1998; Ma *et al.* 2008; Ma & Lin 2009; Lin *et al.* 2016), by taking advantage of the latest diagnosis of *Gaeolaelaps* (Kazemi *et al.* 2014). The newly recorded species in this paper increases the Chinese fauna of *Gaeolaelaps* to 20 species. Also we concluded with an identification key to species of *Gaeolaelaps* from China that may help define natural species groups and, perhaps, clarify the diagnosis of *Gaeolaelaps*. This paper is part of a project which has the objective of increasing our knowledge on the fauna of *Gaeolaelaps* in China.

Material and methods

Specimens were collected in the fur of small wild mammal hosts from Lianghe County, Dehong City, Yunnan, China. Mites were sampled by brushing small mammal hosts, placing the mites in 75% alcohol and then cleaning them in distilled water before mounting in Hoyer's medium. All specimens were examined under a differential interference contrast microscope (Nikon Eclipse Ni-U). Line drawings were made by a drawing tube. All measurements are given in micron (μm). Idiosomal setal nomenclature follows Lindquist & Evans (1965) and Lindquist (1994). Notation of pore-like structures on the idiosoma follows Johnston & Moraza (1991) and Lindquist & Moraza (2008). Leg setal notation and chaetotaxy are based on Evans (1963).

Taxonomy

Genus *Gaeolaelaps* Evans & Till, 1966

Diagnosis. The concept of *Gaeolaelaps* used here is based on diagnoses by Kazemi *et al.* (2014).

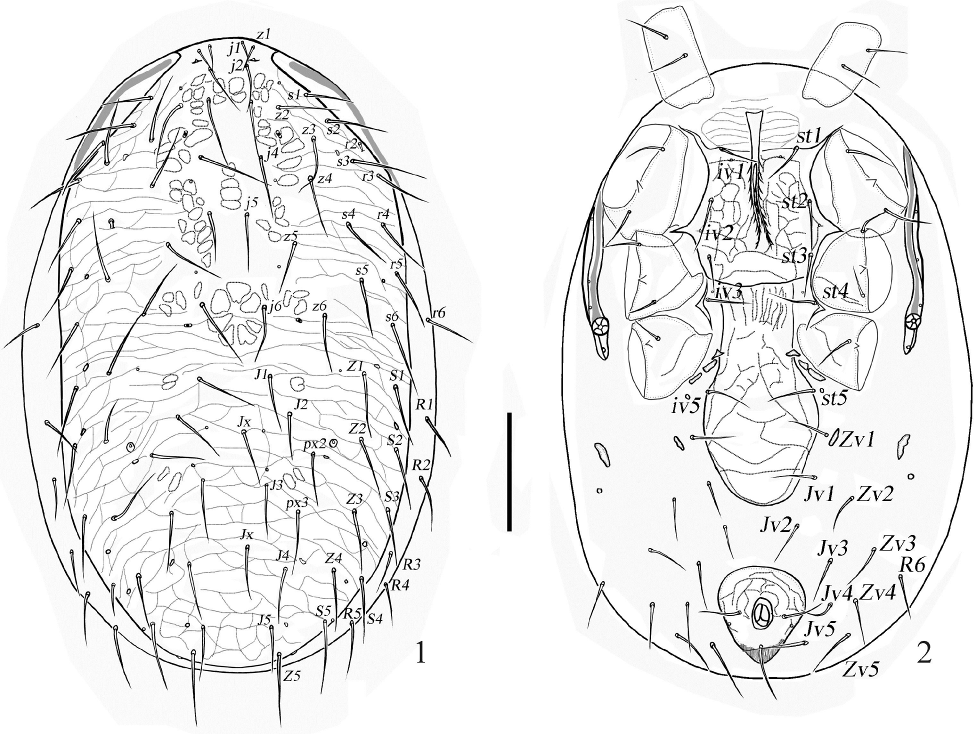
***Gaeolaelaps gillespiei* Beaulieu, 2009** (Figs. 1–10), new record to China

Gaeolaelaps gillespiei Beaulieu, 2009: 2158.

Description. Female. Idiosoma length 538 (488–560), width 352 (337–386).

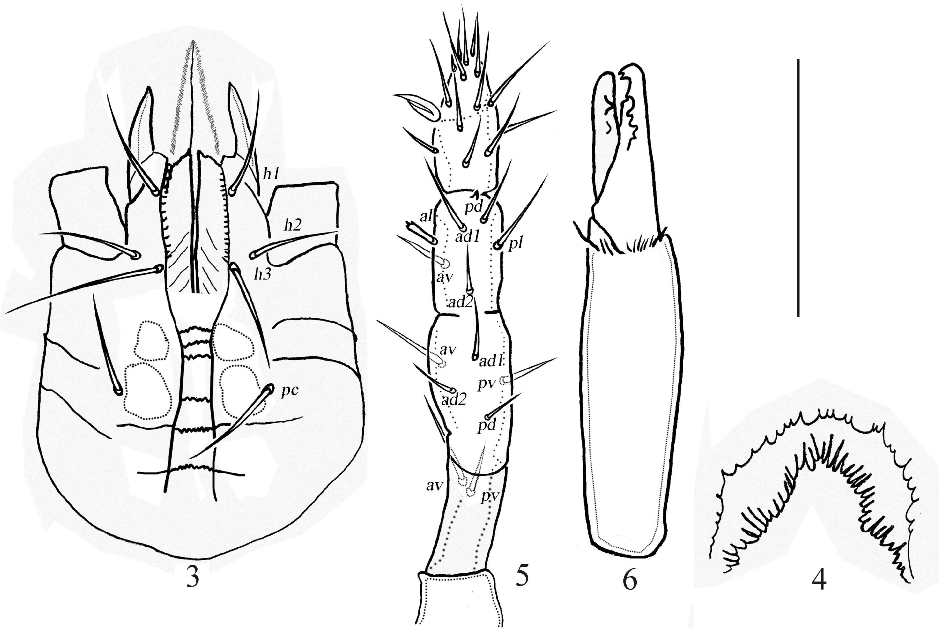
Dorsal idiosoma (Fig. 1). Dorsal shield 529 long, 294 wide at *s6* level, covering most of dorsal idiosoma; reticulate throughout; with 39 pairs of needle-like setae, of which some of the most posterior pairs (e.g. *J4*–*J5*, *Z5*) with a few minute barbs; two unpaired median setae *Jx* between setae *J2*–*J3* and *J3*–*J4*. Dorsal shield setae *j1* 24, *j2* 47, *j3* 59, *j4* 53, *j5* 53, *j6* 65, *z1* 21, *z2* 38, *z3* 59, *z4* 56, *z5* 32, *z6* 53, *s1* 23, *s2* 56, *s3* 68, *s4* 50, *s5* 53, *s6* 68, *r2* 46, *r3* 53, *r4* 53, *r5* 53, *J1* 56, *J2* 44, *J3* 47, *J4* 50, *J5* 41, *Jx1* 53, *Jx2* 50, *Z1* 56, *Z2* 56, *Z3* 56, *Z4* 53, *Z5* 56, *S1* 56, *S2* 53, *S3* 59, *S4* 29, *S5* 62 long. Setae *r6* 44, *R1* 27, *R2* 38, *R3* 35, *R4* 35, *R5* 47. Dorsal shield with 21 pairs of discernible pore-like structures.

Ventral idiosoma (Fig. 2). Tritosternum with a narrow columnar base, 56 long, 12 wide at base, six wide at apex, and two free pilose laciniae 76. Presternal area weakly sclerotised, granulate-lineate. Sternal shield 115 long, 147 wide, distinctly reticulate throughout except for a narrow smooth area posteriorly; anterior margin of shield straight, posterior margin slightly convex; shield bearing three pairs of smooth setae *st1* (38), *st2* (44) and *st3* (38), and two pairs of poroids, *iv1* slit-like and *iv2* sub-oval. Metasternal setae (38) and poroids *iv3* on soft cuticle. Epigynal shield (full length 188) tongue-shaped, very slightly broadened posteriorly, 97 wide, between *st5* and *Zv1*, epigynal shield with a Λ-shape; *st5* (41) on lateral margins of shield, paragenital poroids *iv5* on soft cuticle, near level of coxae IV posterior edges. Anal shield somewhat pear-shaped, anterior margin of shield broadly rounded, 82 long, 73 wide, lineate-reticulate anteriorly and laterally; circumanal setae smooth, postanal seta (53) longer than para-anal setae (35); cribrum well developed; anal opening (26 long, 18 wide) located almost entirely on anterior half of shield; para-anal gland pores *gv3* on lateral shield margins at level of the posterior edge of anal opening. Peritrematal shields relatively well developed throughout, anteriorly fused to dorsal shield behind setae *z1*. Peritremes reaching anterior margin of *s1*. Opisthogastric soft integument with pair of primary metapodal platelets moderately small, narrow, laterad of *Zv1*–*Zv2*; paragenital platelet narrow, beside seta *Zv1*; an additional pair of minute metapodal platelets minute, posterior to primary metapodals; 11 pairs of long, needle-like setae *Jv1* 41, *Jv2* 38, *Jv3* 38, *Jv4* 44, *Jv5* 56, *Zv1* 32, *Zv2* 38, *Zv3* 35, *Zv4*, 41, *Zv5* 47, *R6* 41 long.



Figures 1, 2. *G. gillespiei*, ♀. 1. Dorsal idiosoma; 2. Ventral idiosoma. Scale bar = 100 µm.

Gnathosoma (Fig. 3). Anterior margin of epistome somewhat rounded and denticulate (Fig. 4). Corniculi horn-like, 40 long. Salivary stylets narrow and apically pointed, aligned beneath corniculi. Labrum acuminate, pilose, considerably longer than corniculi. Hypostomal and capitular setae smooth, *h3* (44) > *h1* (43) > *pc* (41) > *h2* (36). Deutosternal groove with six rows of 17–20 denticles each; lateral margins of deutosternum subparallel. Second segment of chelicerae (Fig. 6) 120 long, 40 wide; fixed digit of chelicera 72 long, with seven teeth. Movable digit of chelicera 65 long, bidentate. Palp (Fig. 5) 202 long, palp chaetotaxy normal for Laelapidae, palp apotele 2-tined.



Figures 3–6. *G. gillespiei*, ♀. 3. Gnathosoma; 4. Epistome; 5. Palps; 6. Chelicera. Scale bar = 100 µm.

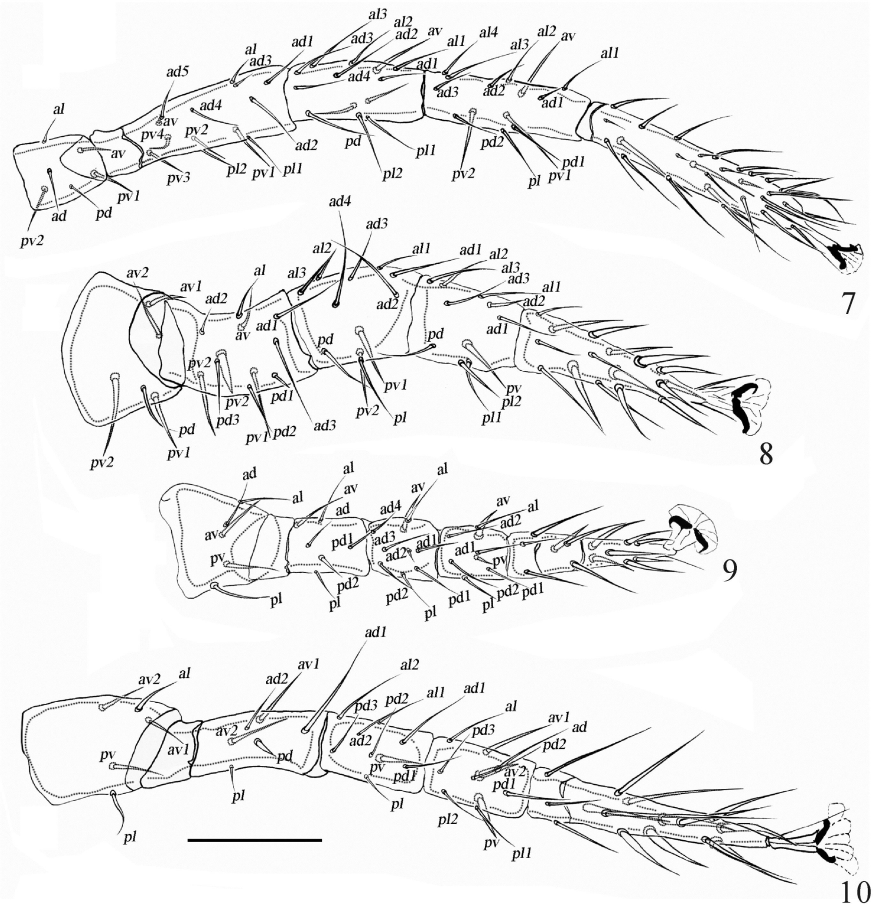
Legs (Figs. 7–10). Leg chaetotaxy normal for Laelapidae. Lengths of legs I–IV 293, 265, 200 and 286, respectively. Leg setae mostly thin and moderately long, except: trochanter I with *al* short; trochanter II with *pv2* slightly thickened; femur II with *pv2* thickened, *ad2* and *pd1* short; femur III with *pd2* slightly thickened, *ad*, *pd2* and *pl* short; femur IV with *av1* and *pd* slightly thickened, *ad2*, *pd* and *pl* short; genu II with *pv1* slightly thickened, and genu III–IV with ventrals slightly thickened; tibia II with *pv* thickened; tibia III with *av* thickened, *av* and *pv* short; tibia IV with *av* and *pv* thickened.

Specimens examined. 5♀, **China,** Yunnan, Dehong, Lianghe, from *Eothenomys miletus*, 24-X-2010, Xianguo GUO; the fur of *Rattus steni*, 26-VII-2010, Xianguo GUO; the fur of *Anourosorex squamipes*, 16-VIII-2004, Xianguo GUO.

Table 1. Chaetotaxy on legs of *Gaeolaelaps gillespiei* Beaulieu, 2009

Leg	Trochanter	Femur	Genu	Tibia
I	1, 1/1, 1/1, 2	1, 5/1, 0/4, 2	3, 4/1, 1/2, 2	4, 3/1, 2/2, 1
II	0, 0/2, 1/1, 1	1, 2/1, 2/3, 2	3, 4/0, 1/2, 1	3, 3/1, 1/1, 2
III	1, 0/2, 0/1, 1	1, 1/1, 2/0, 1	1, 4/1, 2/0, 1	1, 2/1, 2/1, 1
IV	1, 1/1, 0/1, 1	0, 2/2, 1/0, 1	2, 2/0, 3/1, 1	1, 1/2, 3/1, 2

* Chaetotaxy of legs on each section represent as *al*, *ad/av*, *pd/pv*, *pl*



Figures 7–10. *G. gillespiei*, ♀. Right legs, dorsal views. 7. Leg I; 8. Leg II; 9. Leg III; 10. Leg IV.

Checklist of *Gaeolaelaps* from China

1. *G. singuloides* (Gu & Duan, 1993)—Gu & Duan, 1993 (body of *Gryllus* sp., Yunnan)
2. *G. baichengensis* (Ma, 2000)—Ma, 2000a (poplar forest soil, Jilin)
3. *G. brevipilis* (Hirschmann, 1969)—Ma, Kuang & Lin, 2008 (humus soil, Shandong; forest soil, Henan)
4. *G. xiningensis* (Ma & Lin, 2009)—Ma & Lin, 2009 (scraps of wood, Qinghai)
5. *G. postreticulatus* (Xu & Liang, 1996)—Xu & Liang, 1996 (moss, Anhui and Zhejiang)
6. *G. kargi* (Costa, 1968)—Teng *et al.*, 1992; Lin *et al.*, 2016 (litter, moss, Heilongjiang; under bark of tree, Ningxia)
7. *G. haiyuannensis* (Bai, Chen & Gu, 1994)—Bai *et al.*, 1994 (cave of *Myrmos* sp., Ningxia)
8. *G. subminor* (Gu & Bai, 1991)—Gu & Bai, 1991 (fur of *Cricetulus barabensis*, Ningxia)
9. *G. tengi* (Gu & Bai, 1991)—Gu & Bai, 1991 (fur of *Phodopus roborovskii*, Ningxia)
10. *G. praesternaloides* (Ma & Yin, 1998)—Ma & Yin, 1998 (forest soils, Heilongjiang)
11. *G. dailingensis* (Ma & Yin, 1998)—Ma & Yin, 1998 (forest soils, Heilongjiang)
12. *G. debilis* (Ma, 1996)—Ma, 1996 (nest of *Citellus dauricus*, Jilin)
13. *G. praesternalis* (Willmann, 1949)—Teng, 1982 (fur of *Apodemus agrarius*, Heilongjiang)

14. *G. condinna* (Teng, 1982)—(Teng, 1982) (nest of *Cricetus triton*, Beijing)
15. *G. aculeiferoides* (Teng, 1982)—Teng, 1982 (nest of *Citellus dauricus*, Beijing)
16. *G. changlingensis* (Ma, 2000)—Ma, 2000b (soil, Jilin)
17. *G. zhoumanshuae* (Ma, 1997)—Ma, 1997 (humus soil, soil under weeds, Jilin)
18. *G. aculeifer* (Canestrini, 1884) — Teng *et al*., 1993 (nest of *Microtus fortis*, Inner Mongolia)
19. *G. taitzujungi* (Samšiňák, 1964) — Teng *et al*., 1993 (nest of *Coptotermes formosanus*, Guangdong)
20. *G. gillespiei* Beaulieu, 2009 rec. nov — (fur of *Anourosorex squamipes*, *Eothenomys miletus* and *Rattus steni*, Yunnan)

Remarks. The following additional species, mostly described as *Hypoaspis* or *Gaeolaelaps*, may have been wrongly placed into *Gaeolaelaps* may not belong to this genus as per Kazemi *et al*., 2014: *H. lubrica* Voigts & Oudemans, 1904; *H. Guiyang* Ma & Lin, 2009; *H. lepiternails* Ma, 2004; *H. submontana*, Bai *et al*., 1994; *H. longichaetus* Ma, 1996; *G. orientails* Bei & Yin, 1999; *H. chongqingnsis*, Ma *et al*., 2003; *H. diomphalia* Yin & Qin, 1984; *H. wufengensis* Liu & Ma, 2003.

Key to species of *Gaeolaelaps* from China (female)

1. Dorsal shield with 39 pairs of setae or more ········ 2

-\. Dorsal shield with fewer than 39 pairs of setae ········ 17

2. Dorsal setae 39 pairs ········ 3

-\. Dorsal setae more than 39 pairs ········ *G. taizuiungi*

3. Dorsal shield without additional seta ········ 4

-\. Dorsal shield with additional seta ········ 11

4. Presternal area with reticulate structures ········ 5

-\. Presternal area with a pair of plates ········ 7

5. Sternal shield with a retuse anterior margin and a retuse or wavy posterior margin ········ 6

-\. Sternal shield with a straight anterior margin and a raised posterior margin ········ *G. aculeifer*

6. Sternal shield without any reticulate pattern; genital shield shrunk at *st4*, the latter expanding to round; anal shield pear-like ········ *G. changlingensis*

-\. Sternal shield with a retuse anterior margin and a wavy posterior margin; genital shield long tongue-shaped, anal shield rounded triangle-shaped, anal pore large ········ *G. subminor*

7. Dorsal shield covering all of the body ········ 8

-\. Dorsal shield covering most of the body ········ 10

8. Dorsal setae simple, smooth and short ········ *G. brevipilis*

-\. Dorsal setae simple, medium length, or reaching the bottom of latter setae ········ 9

9. The lateral margin of dorsal shield arc-shaped, not parallel on both sides; at the end of peritrematal shield with gnawed inner margin; the latter of genital shield obviously swollen········ *G. prasternaloides*

-\. The lateral margin of dorsal shield straight, both sides parallel to each other; peritrematal shield without gnawed inner margin; genital shield narrow ········ *G. praesternalis*

10. Reticulate pattern covering all of the dorsal shield, the lateral margin of shield arc-shaped, not parallel on both sides ········ *G. dailingensis*

-\. Reticulate pattern covering opisthonotal region of dorsal shield, the lateral margin of shield straight, both sides parallel to each other ········ *G. postreticulatus*

11. Dorsal setae with a single additional seta ···················· 12
-. Dorsal setae with more than one additional seta ···················· 13
12. Genital shield narrow, tongue-shaped; presternal area corrugated, like rectangle; sternal shield with a straight anterior margin and a retuse posterior margin; metapodalia reniform; dorsal setae short and small, needle-like; soft opisthogastric cuticle with 8 pairs of setae···················· *G. aculeiferoides*
-. Genital shield wide, tongue-shaped; presternal area, reticulate, wide hexagon-shaped; sternal shield with a straight anterior margin and arcuate posterior margin, bulging out to the level of the half of coxa III; metapodalia microscler, approximate to rod-like ···················· *G. concinna*
13. Dorsal setae special, *z5* with inconspicuous spiny branches···················· *G. gillespiei* rec. nov
-. All dorsal setae simple, without any spiny branches ···················· 14
14. Dorsal setae short and small, needle-like, not reaching the bottom of latter setae ····················15
-. Dorsal setae long, almost reaching or reaching the bottom of latter setae ····················*G. singuloides*
15. Presternal area without plate-like structure, *st1* located on presternal areas; metapodalia large and oval-shaped ···················· *G. debilis*
-. Presternal areas with a pair of plates, covered with transverse striation; *st1* located on margin of sternal shield; metapodalia long rod-like or oblong ···················· 16
16. Three additional setae, dorsal setae thin and smooth; the two presternal reticulate areas connected with each other; soft opisthogastric cuticle with about 20 pairs of setae ···················· *G. xiningensis*
-. Four additional setae, dorsal setae thin and short; two presternal reticulate area separated from each other; soft opisthogastric cuticle with about 9–10 pairs of setae···················· *G. baichengensis*
17. Dorsal shield covering all of the body; presternal with a pair of line and point filling area ···················· *G. kargi*
-. Dorsal shield covering almost all of the body, the margin of body exposed; presternal area with reticulate pattern ···················· 18
18. Dorsal setae length moderate, almost reaching the bottom of latter setae ····················*G. haiyuanensis*
-. Dorsal setae short, not reaching midpoint of prior and latter setae ···················· 19
19. The body ovate-oblong, the latter dorsal shield narrowed gradually, baring a large area; dorsal setae 37 pairs; presternal area with a pair of connected reticulate circles; sternal shield with a retuse anterior margin and a raised posterior margin; the latter of genital shield obviously shrunk; a pair of metapodalia thin and long; soft opisthogastric cuticle with 6 pairs of simple setae ···················· *G. zhoumanshuae*
-. The body oblong-shaped, dorsal setae 35 pairs; presternal area with reticulate pattern; sternal shield with a straight anterior margin and a retuse posterior margin; genital shield long, the latter segment swelling, with obvious reticulate pattern; four pairs of metapodalia, the outmost one narrow and long, the others microscler; soft opisthogastric cuticle with 10 pairs of simple setae ···················· *G. tengi*

Discussion

Most members of the subfamily Hypoaspidinae are usually found in litter and soil substrates, while species of these and other genera are routinely or occasionally encountered in the nest of mammals or arthropods or directly associated with insects (Krantz & Walter 2009). Some hypoaspidine mites, such as *G. gillespiei*, *Stratiolaelaps miles*, *G. aculeiferoides* and *Cosmolaelaps chianensis*, are collected from the pelage of wild mammals (Guo *et al.* 1995, Yang *et al.* 2015). No evidence, however, has been found that hypoaspidine mites are real ectoparasites of mammals. Some species of *Gaeolaelaps* show potential as biocontrol agents against fungus gnats and flower thrips (Beaulieu & Weeks 2007). The hypoaspidine mites collected from wild mammals are probably predacious arthropods.

Acknowledgements

This work was supported by the National Natural Science Foundation of China (31501847, 31093430), the Key Research and Development Program of Shandong Province (2016GNC110012, 2017CXGC0207), and the Funds of Shandong "Double Tops" Program (SYL2017XTTD06).

References

Bai XL, Chen BF & Gu YM. 1994. Three new species of the genus *Hypoaspis* (Acari: Laelapidae) from Ningxia, China. *Entomotaxonomia*, 16(4): 295–301.

Beaulieu F. 2009. Review of the mite genus *Gaeolaelaps* Evans & Till (Acari: Laelapidae), and description of a new species from North America, *G. gillespiei* n. sp. *Zootaxa*, 2158: 33–49.

Beaulieu F & Weeks AR. 2007. Free-living mesostigmatic mites in Australia: their roles in biological control and bioindication. *Australian Journal of Experimental Agriculture*, 47(4): 460–478.

Evans GO. 1963. Observation on the chaetotaxy of the legs in the free-living Gamasina (Acari: Mesostigmata). *Bulletin of British Museum* (*Natural History*), *Series Zoology*, 10: 277–303.

Faraji F, Abedi L & Ostovan H. 2008. A new species of *Hypoaspis* Canestrini from Iran with a key to the Iranian species of *Hypoaspis* (Acari, Gamasina, Hypoaspididae). *Zoosystematics and Evolution*, 84(2): 205–209.

Karg W. 1962. Zur Systematik und Postembryonalen Entwicklung der Gamasiden (Acarina, Parasitiformes) landwirtschaftlich genutzter Boden. *Mitteilungen aus dem Zoologischen Museum in Berlin*, 38: 23–119.

Karg W. 1982. Zur Kenntnis der Raubmilbeng *Hypoaspis* Canestrini 1884 (Acarina, Parasitiformes). *Mitteilungen aus dem Zoologischen Museum in Berlin*, 58: 233–256.

Karg W. 1987. Neue Raubmilbenarten der Gattung *Hypoaspis* Canestrini 1884 (Acarina, Parasitiformes). *Zoologische Jahrbucher Abteilung fűr Systematik Őkologie und Geographie der Tiere*, 114: 289–302.

Karg W. 1989. Zur Kenntnis der Untergattungen *Geolaelaps*, *Alloparasitus* und *Laelaspis* der Raubmilbengattung *Hypoaspis* Canestrini 1884 (Acarina, Parasitiformes). *Mitteilungen aus dem Zoologischen Museum in Berlin*, 65: 115–126.

Kazemi S, Rajaei A & Beaulieu F. 2014. Two new species of *Gaeolaelaps* (Acari: Mesostigmata: Laelapidae) from Iran, with a revised generic concept and notes on significant morphological characters in the genus. *Zootaxa*, 3861(6): 501–530.

Gu YM & Bai XL. 1991. Two new species of the genus *Hypoaspis* (Acari: Laelapidae). *Acta Zootaxonomica Sinica*, 16(2): 181–185.

Gu YM & Duan QX. 1993. Two new species of Laelapidae from Yunnan, China. *Acta Zootaxonomica sinica*, 18(1): 48–53.

Guo XG, Ye BH, Gu YM & Chen YM. 1995. Species—abundance distribution of Gamasid mite community on small mammals in western Yunnan, China. *Acta Parasitology Medicine Entomology Sinca*, 2(1): 56–61.

Halliday RB & Lindquist EE. 2007. Nomenclatural notes on the names *Gaeolaelaps* and *Geolaelaps* (Acari: Laelapidae). *Zootaxa*, 1621: 65–67.

Hyatt KH. 1964. A collection of Mesostigmata (Acari) associated with Coleoptera and Hemiptera in Venezuela. *Bulletin of the British Museum* (*Natural History*) *Zoology*, 11: 465–509.

Johnston DE & Moraza ML. 1991. The idiosomal adenotaxy and poroidotaxy of Zerconidae (Mesostigmata: Zerconina). *In*: Dusbábek F & Bukva V (Eds.), *Modern Acarology*. Academia, Prague, pp. 349–356.

Kazemi S, Rajaei A & Beaulieu F. 2014. Two new species of *Gaeolaelaps* (Acari: Mesostigmata: Laelapidae) from Iran, with a revised generic concept and notes on significant morphological characters in the genus. *Zootaxa*, 3861(6): 501–530.

Krantz GW & Walter DE. 2009. *A Manual of Acarology. 3rd Edition.* Texas Tech University Press, Lubbock, 807 pp.

Lin JZ, Bai XL, Zhang YX, Chen X, Sun L, Saito Y &Ma LM. 2016. Redescription and distribution of *Hypoaspis kargi* Costa in China (Acari: Mesostigmata: Laelapidae). *Wuyi Science Journal*, 32: 32–34.

Lindquist EE. 1994. Some observations on the chaetotaxy of the caudal body region of gamasine mites (Acari: Mesostigmata), with a modified notation for some ventrolateral body setae. *Acarologia*, 35: 323–326.

Lindquist EE & Evans GO. 1965. Taxonomic concepts in the Ascidae, with a modified setal nomenclature for the idiosoma of the Gamasina (Acarina: Mesostigmata). *Memoirs of the Entomological Society of Canada*, 47: 1–64.

Lindquist EE & Moraza ML. 2008. A new genus of flower-dwelling melicharid mites (Acari: Mesostigmata: Ascoidea) phoretic on bats and insects in Costa Rica and Brazil. *Zootaxa*, 1685: 1–37.

Ma LM. 1996. Three new species of the genus *Hypoaspis* from Jilin province, China (Acari: Laelapidae). *Acta Zootaxonomica Sinica*, 21(1): 48–54.

Ma LM. 1997. Three new species of Gamasina in soil (Acari: Laelapidae: Parasitidae, Pachylaelatidae). *Acta Arachnologica Sinica*, 6(1): 31–35.

Ma LM. 2000a. A new species of the genus *Hypoaspis* from Jilin province, China (Acari: Gamasina). *Acta Zootaxonomica Sinica*, 25(4): 384–386.

Ma LM. 2000b. Description of a new species of the Gamasid mite (Acari: Laelapidae). *Entomotaxonomia*, 22(2):150–152.

Ma LM. 2004. Two new species of genera *Hypoaspis* and *Pseudoparasitus* (Acari: Gamasina: Laelapidae). *Acta Arachnologica Sinica*, 13(1): 18–22.

Ma LM, Kuang Y & Lin JZ. 2008. Descriptions of female and deutonymph of *Hypoaspis brevipilis* Hirschmann, 1969 (Acari: Mesostigmata: Laelapidae). *Entomological Journal of East China*, 17(1): 6–8.

Ma LM & Lin JZ. 2009. On five new species of the genus *Hypoaspis* and *Cosmolaelaps*, with sypplementary descriptions of *Cosmolaelaps xiajiangensis* and *Haemolaelaps cordatus* (Acari: Mesostigmata: Laelapidae). *Acta Arachnologica Sinica*, 18(1): 28–39.

Ma LM & Yin XM. 1998. Two new species of the genus *Hypoaspis* (Acari: Gamasina: Laelapidae) from Hei longjiang province, China. *Entomotaxonomia*, 20(3): 223–229.

Nemati A & Mohseni M. 2013. Two new species of Gaeolaelaps (Acari: Laelapidae) from Iran. *Zootaxa*, 3750(1): 71–82.

Rosario RMT. 1981. Philippine Hypoaspidinae (Acarina: Mesostigmata: Laelapidae). *Philippine Entomologist*, 5: 23–82.

Ryke PAJ. 1963. Some free-living Hypoaspidinae (Acari: Mesostigmata) from South Africa. *Revista de Biologia*, 5: 1–15.

Teng KF. 1982. On some new species and new records of Laelapid mite from China. *Acta Zootaxonomica Sinica*, 7(2): 161–162.

Teng GF, Zhang XM & Cui YQ. 1992. A new species and a new record of the genus *Hypoaspis* From China (Acari: Laelapidae). *Acta Zootaxonomica Sinica*, 17(2): 196–198.

Teng GF, Wang DQ, Gu YM & Meng YC. 1993. *Economic Insect Fauna of China. Fasc. 40. Acari: Dermanyssoideae*. Science Press, Beijing, 391 pp.

Tenorio JM. 1982. Hypoaspidinae (Acari: Gamasida: Laelapidae) of the Hawaiian islands. *Pacific Insects*, 24(3-4): 259–274.

Van Aswegen PIM & Loots GC. 1970. A taxonomic study of the genus *Hypoaspis Canestrini* sens. lat. (Acari: Laelapinae) in the Ethiopian region. *Publicacoes Culturais da Companhia de Diamantes de Angola*, 82: 167–213.

Walter DE & Oliver JH. 1989. *Geolaelaps oreithyiae*, n. sp. (Acari: Laelapidae), a thelytokous predator of arthropods and nematodes, and a discussion of clonal reproduction in the Mesostigmata. *Acarologia*, 30: 293–303.

Xu XN & Liang LN. 1996. Four new species of the Hypoaspidinae (Acari: Laelapidae) from moss in China. *Systematic and Applied Acarology*, 1: 189–197.

Yang PB, Song WY, She HY, Wu XS, Jiang P, Zhou YJ, Hou P & Guo XG. 2015. Diversity of ectoparasites on *Eothenomys miletus* in mountainous areas of southwest Sichuan. *Sichuan Journal of Zoology*, 34(2): 239–244.